



Data Integration with SMW+

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- Motivation
- General workflow and architecture
- OntoStudio (with demo)
 - From relational database to wiki vocabulary
- SMW+ (with demo)
 - Using external data
 - Enhancing/extending external data
- Summary and Outlook



- Enterprises typically manage their data in relational databases
- Often a landscape of isolated data silos grows
- In contrast, a wiki provides **one** platform for **sharing** information
- Nevertheless,
 - the data bases exist
 - contain valuable information
 - will not be deserted
- Enterprise use cases we see often require access to external data from within the wiki
 - Usually the external data sources are relational databases
 - Wiki is used as a data access and visualisation tool
 - Wiki users should be able to formulate queries



Workflow for Data Integration with SMW+

■ OntoStudio

- Lift database schema
- Model wiki ontology
- Map database ontology to wiki ontology
- Test and refine mappings
- Export ontologies
- Transfer to Wiki server

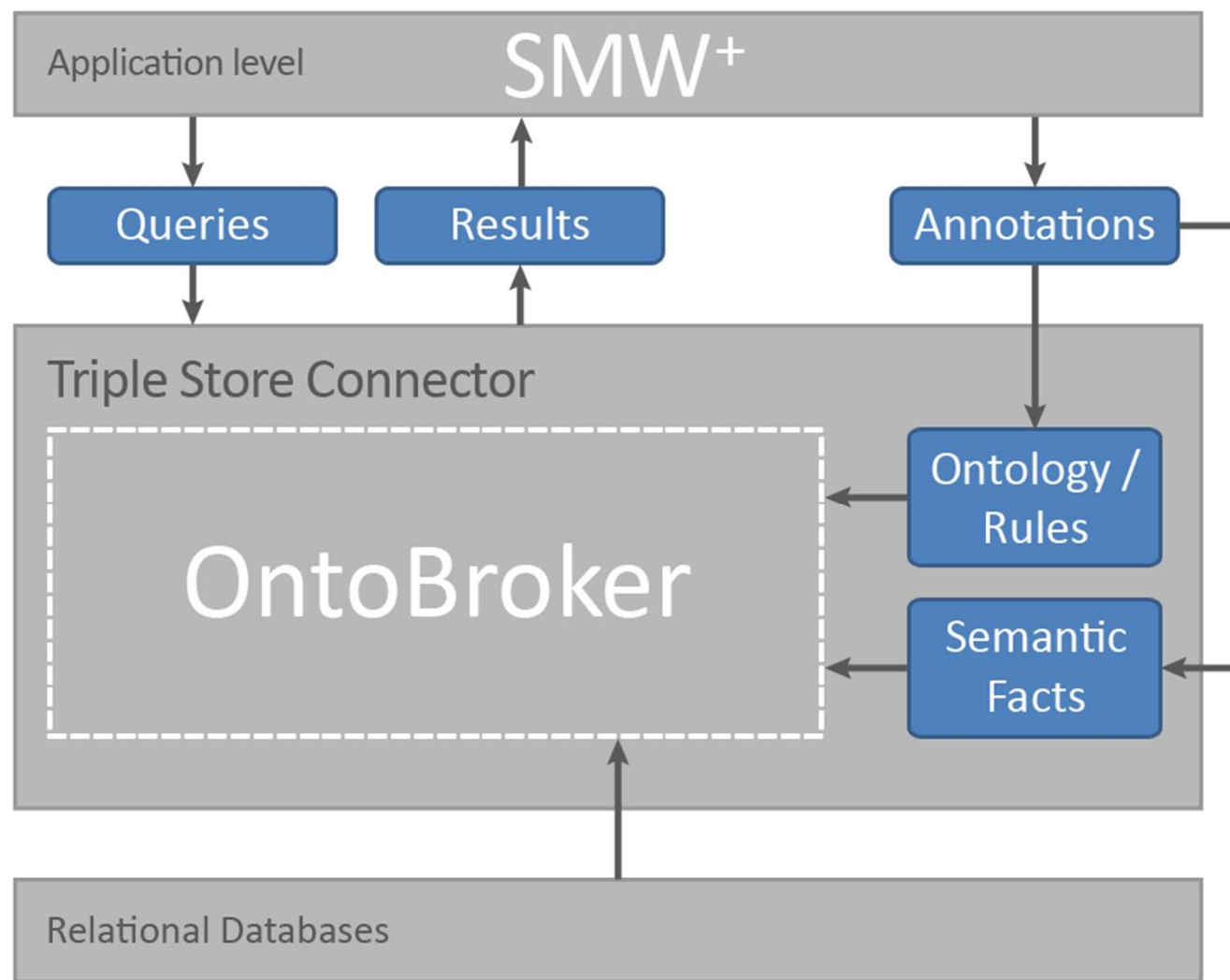
■ SMW+ / TSC

- Import ontologies
- Formulate queries (QI)
- Create articles containing inline queries
- Browse database via Non-Existing-Pages
- Potentially, enhance model via annotations
- Adapt and extend wiki ontology
- Export ontology as OBL

- Import ontology
- Test and refine ontology



Architecture



- Database schemas are table-based and usually geared towards performance not conceptual clarity
- Schemas are **lifted** to an ontological level automatically
 - Tables become classes
 - Foreign-keys become object properties (in the OWL sense)
 - Other columns become data properties
- The result is an **ObjectLogic ontology** representing the database
- This ontology contains **data-access rules** that populate classes and properties
 - These rules are OBL rules **reaching out into the database**
 - Rules are triggered **at query time**



Live Demo of
OntoStudio



OntoStudio: Database Lifting

The image displays three overlapping 'Update database import' dialog boxes, illustrating the steps for database lifting in OntoStudio.

Left Dialog: Edit database connection data

Database: mssqlserver
Database name: OS1.6 Demo DB
Host: data
Port: 1433
User name: sa

< Back Next >

Middle Dialog: Import

Select table owners

Table owner

- ☒ dbo
- ☐ demo
- ☐ guest
- ☐ os_tester
- ☐ test

Refresh

< Back Next >

Right Dialog: Import

Select tables to import

Tree view:

- ☒ cars
 - ☒ name
 - ☒ company
 - ☒ type
- ☒ countries
 - ☒ name
 - ☒ continent
- ☒ dtproperties
- ☒ prices
- ☒ sales
 - ☒ region
 - ☒ car
 - ☒ amount

☐ Select All
☐ Auto select referenced tables

Refresh

< Back Next > Finish Cancel



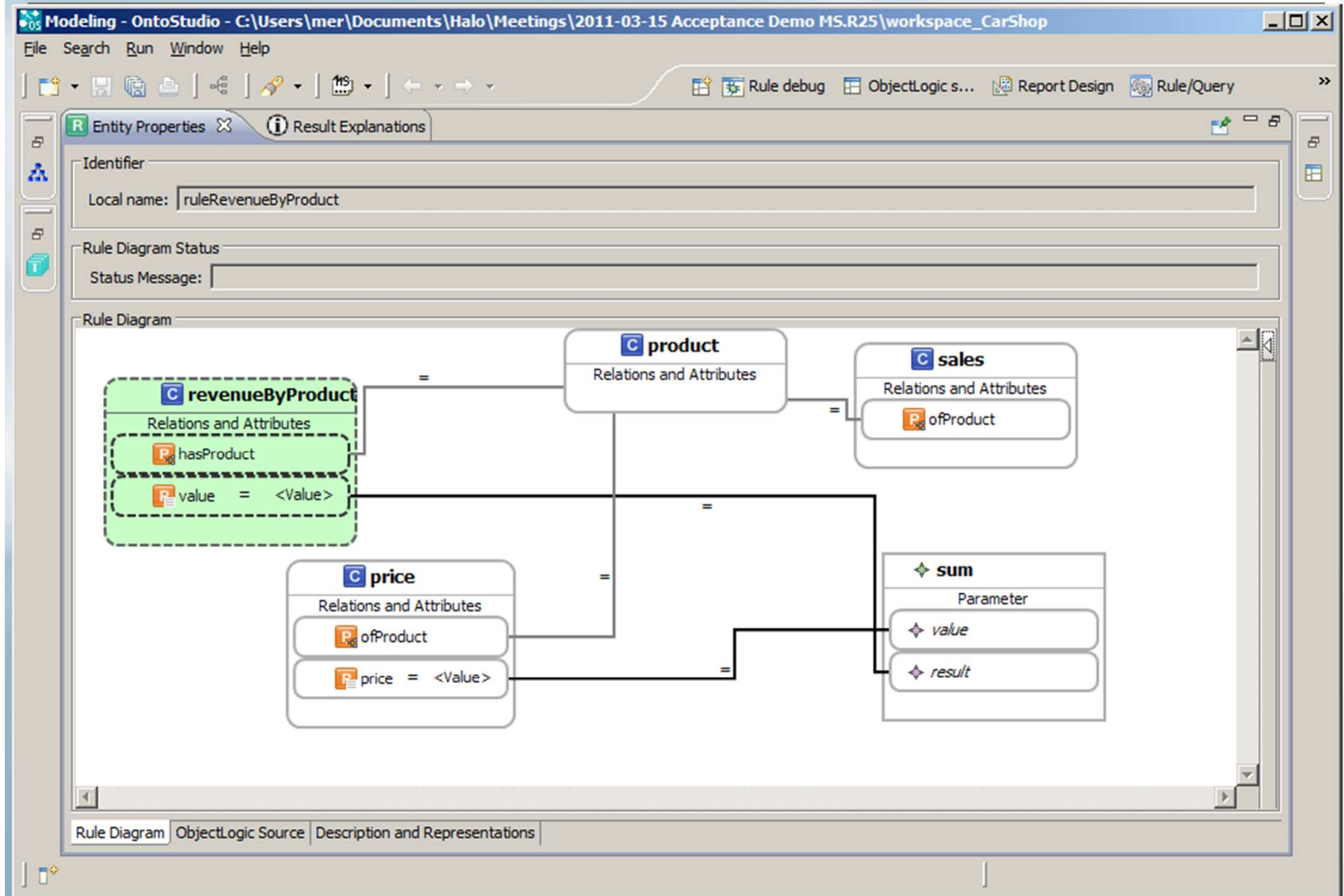
OntoStudio: Modeling

The screenshot displays the OntoStudio application window. The title bar indicates the file path: C:\Users\mer\Documents\Halo\Meetings\2011-03-15 Acceptance Demo MS.R25\workspace_CarShop. The main menu includes File, Search, Run, Window, and Help. The toolbar contains icons for file operations and navigation. The 'Ontology Navigator' on the left shows a tree structure for 'ProductSalesDemo [ObjectLogic]'. The 'Entity Properties' window on the right is active, showing the 'sales' property. The 'Properties' table lists the following data:

Properties	Range	Min	Max		
amount	int	0	N	✗	
inRegion	region	0	N	✗	
ofProduct	product	0	N	✗	

The 'Instances' window at the bottom left shows two instances: 'SoldInAsia' and 'SoldInGermany'. The bottom of the 'Entity Properties' window has tabs for 'Properties', 'Comments & Labels', 'Synonyms', and 'Meta Information'.

OntoStudio: Graphical Rule Modeling



OntoStudio: Mapping

The screenshot displays the OntoStudio Mapping interface. The main window is titled "Integration - OntoStudio - C:\Users\mer\Documents\Halo\Meetings\2011-03-15 Acceptance Demo MS.R25\workspace_CarShop". The interface is divided into several panes:

- Left Pane (Ontology N):** Shows a tree view of the project structure. The "dbOntology" is selected under "ProductSalesDemo".
- Top Pane (Mapping):** Displays the mapping between the "dbOntology" and the "productOntology". The "countries" class in "dbOntology" is mapped to the "country" class in "productOntology".
- Bottom Left Pane (Attributes/Relations):** Shows the attributes of the "countries" class in "dbOntology":
 - countries_continent [string]
 - countries_name [string]
- Bottom Right Pane (Attributes/Relations):** Shows the attributes of the "country" class in "productOntology":
 - hasName [string]
 - partOf [region]
- Instances:** Two empty tables are shown at the bottom, one for "countries" and one for "country".

The mapping diagram in the center shows the following relationships:

- Two "C" (Class) icons on the left are connected to two "M" (Mapping) icons.
- Two "C" (Class) icons on the right are connected to two "M" (Mapping) icons.
- Arrows indicate the mapping from the "C" icons to the "M" icons.

OntoStudio: Testing

Rule/Query - OntoStudio - C:\Users\mer\Documents\Halo\Meetings\2011-03-15 Acceptance Demo MS.R25\workspace_CarShop

File Search Run Window Help

ObjectLogic s... Report Design Rule/Query Integration Modeling

*Ontology Navigator

- CarShop [ObjectLogic]
- ProductSalesDemo [ObjectLogic]
- dbOntology
- >ontology
 - Classes
 - price
 - product
 - car
 - region
 - continent
 - country
 - sales
 - Properties
 - Rules
 - Queries
 - qCar
 - qContinent
 - qCountry
 - qPrices
 - qSales
 - Mappings
 - cars -> car

Instances

Entity Properties

Identifier

Local name: Run Query

Type:

?price1
...ofProduct: ?product1

Show	Attribute	Restriction	Restriction
<input checked="" type="checkbox"/>	price	=	

Relation	Range	Related classes
inRegion	region	
ofProduct	product	?product1

Query Form ObjectLogic Source Options Description and Representations

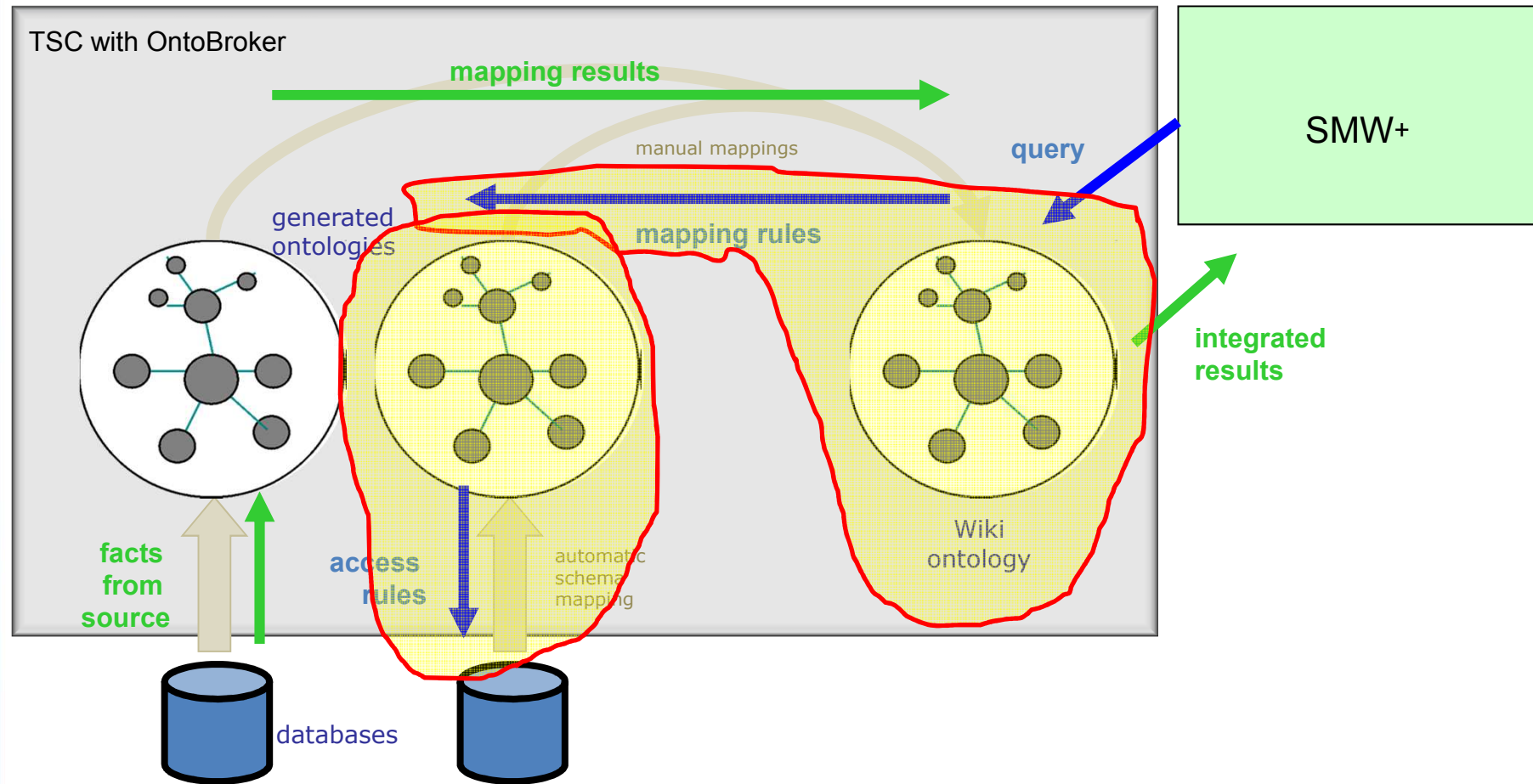
Results Problems Console Explanation Editor Progress

Results for query <http://www.NewOnto1.org/ontology#qPrices> [ProductSalesDemo, <http://www.NewOnto1.org/ontology#>]

?price1_price	?product1_hasName
34000.0	"Audi A3 Sportback"
13000.0	"Audi A2"
15000.0	"Audi A2"
12000.0	"Audi A2"
12500.0	"Audi A2"
135000.0	"Audi A2"
22500.0	"Audi A2"

Internal OntoBroker

Query Answering



■ OntoStudio

- Lift database schema
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- Export ontologies
- Transfer to Wiki server

- Import ontology
- Test and refine ontology

■ SMW+ / TSC

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Import Ontology into Wiki

- The wiki ontology coming from OntoStudio needs to be imported.
- This is a task for the **Deployment Framework (DF)**
- Ontologies can be imported from a file or from a repository
- Technically, the ontology file is converted into the MW XML-format and then imported by wiki tools.
 - The external tool for this task is “onto2mwxml”. It can also handle OWL, RDF/XML, N3, NTRIPLE, **OBL**
 - `smwadmin -i myOntology.obl`



- OBL contains stuff that has no equivalent in the wiki
 - Predicates
 - Mapping rules
 - Queries
- They are stored as a separate file in the wiki and are copied into the TSC as an individual module to be executable.
- TSC:
 - Wikimodule (contains all wiki annotations, incl. the ones imported from OBL) is automatically synched with Wiki
 - TSC-only part from imported OBL (this module is imported by the wikimodule)
 - Other modules, e.g. module created by lifting a database



Wiki Part of
Data Integration



Imported Ontology in OntologyBrowser

The ontology browser lets you navigate through the ontology to easily find and identify items in the wiki. Use the Filter Mechanism at the upper left to search for specific entities in the ontology and the filters below each column to narrow down the given results. Initially the flow of browsing is left to right. You can flip the flow by clicking the big arrows between the columns.

Press Ctrl+Alt+Space to use auto-completion. (Ctrl+Space in IE)

C Category Tree **P** Property Tree **R** Rules

Add subcategory | Add cat. on same level | Rename

- CarDealership (open)
- GardeningLog (open)
- Price (open)
- Product (open)
 - Car (open)
- Region (open)
 - Continent (open)
 - Country (open)
- Revenue (open)
 - RevenueByCountry **R** **R** (open)
 - RevenueByProduct **R** **R** (open)
- Sales (open)
- TopSeller **R** (open)

Filter

I Instances

Rename instance | Delete instance | Create instance

- Obl term <http://www.NewOnto1.org/dbOntolog>
- Obl term <http://www.NewOnto1.org/dbOntolog>
- Obl term <http://www.NewOnto1.org/dbOntolog>
- Obl term <http://www.NewOnto1.org/dbOntolog>
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- Obl term <http://www.NewOnto1.org/dbOntolog>
- Obl term <http://www.NewOnto1.org/dbOntolog>

Filter

P Properties Type/Range

Add property to domain: 'Car'


HasPrice	(open)	(0)	Number
			0 ... *
HasManufacturer	(open)	(0)	String
			0 ... *
HasName	(open)	(0)	String
			0 ... *

Filter






Imported rules

- Rules of an ontology are stored on a separate page for each ontology.

 ruleRevenueByCountry

Status: active Rule format: Pretty print

```
"?C"(?B,?F):RevenueByCountry AND
"?C"(?B,?F)[InCountry->?F] AND
"?C"(?B,?F)[Value->?B] :-
  ?B = sum { ?K [?F] |
    ?F:Country AND
    ?G:Sales AND
    ?G[InRegion->?F] AND
    ?I:Price AND
    ?I[InRegion->?F] AND
    ?I[Price->?K] }.
```

 Property  Category  Instance



Example of an Imported Page

- Imported page **Property:HasName**
 - Property has two domains: **Product**, **Region**
 - Type is **String**
 - The **original URI** in the ontology is
 - <http://www.NewOnto1.org/ontology#hasName>
 - This is separately stored in a mapping table to provide fast access whenever wiki names have to be replaced by OB URIs or vice-versa.
 - The (automatically created) bundle is **Ontology-v9**

Facts about HasName ⓘ

RDF feed 

Has domain and range **Category:Product (?)** + , and **Category:Region (?)** + 

Has type **String** + 

Ontology URI <http://www.NewOnto1.org/ontology#hasName>  + 

Part of bundle **Ontology-v9** + 



Query for Integrated Data

```

{{#ask: [[Category:Price]]
[[InRegion.HasName::+]]
[[OfProduct.HasName::+]]
[[OfProduct.HasManufacturer::+]]
| ?Price
| ?InRegion.HasName=Region name
| ?OfProduct.HasName=Product name
| ?OfProduct.HasManufacturer=Manufacturer
| source=tsc
}}

```

Price	Region name	Product name	Manufacturer
13,000	France	Audi A2	Audi AG
15,000	Germany		
12,000	Italy		
12,500	Portugal Spain		
20,000	France	Audi A3	Audi AG
22,500	Germany		
20,500	Italy		
19,500	Portugal Spain		
19,750	Spain	Audi A3 Sportback	Audi AG
26,000	France		
28,000	Germany		
25,500	Italy		
24,500	Portugal	Audi A3 Sportback	Audi AG
24,700	Spain		



Query in the Query Interface

Create query

Load query

▶ Query options

▼ Query definition

Query name

Add Category

Add Property

Add Instance

Main Query : Add property

Property:

OfProduct

Type: Page | Range: Product

Property value: ☒ Show in results

Column label:

☐ Value must be set

Restriction: ☒ None ☐ Specific value ☐ Subquery

Add

Cancel

Query as tree

Query source

Main Query

Price

Price

= all values

InRegion.HasName

= all values

▼ Result

▶ Format Query

▼ Result Preview | [Show full result](#)

dbo_prices_565041163_Audi_A3_Sportback_France_)	26,000	France
dbo_prices_565041163_Audi_A3_France_)	20,000	France
dbo_prices_565041163_Audi_A2_France_)	13,000	France
dbo_prices_565041163_Audi_A3_Sportback_Germany_)	28,000	Germany
dbo_prices_565041163_Audi_A3_Germany_)	22,500	Germany
dbo_prices_565041163_Audi_A2_Germany_)	15,000	Germany
dbo_prices_565041163_Audi_A3_Sportback_Italy_)	25,500	Italy



- An instance created from a database mapping is represented by a red-link.
- In case that there is no real database key, OntoBroker creates one automatically.
- If the user clicks on a red link, the non-existing page handler takes care of it
 - It displays all statements about this instance as well as all statements which have this instance as object.







Non-Existing Pages

This is the NEP page with the default template. It can be user-defined.

Create the article **Dbo cars 565041163 Audi A2)** with the content displayed below. [🔗](#)

This resource is stored in the underlying knowledge-base with the following URI: <obl:term#%3Chttp://www.NewOnto1.org/dbOntology%23c%3E(%3Chttp://www.NewOnto1.org/dbOntology/dbo%23cars_565041163%3E,%22Audi%20A2%22)>

Dbo cars 565041163 Audi A2) belongs to the following categories: Cat [Car](#), Cat [Product](#), Cat [TopSeller](#)

Facts about <i>Dbo cars 565041163 Audi A2)</i>		References to <i>Dbo cars 565041163 Audi A2)</i>	
 P	 O	 S	 P
HasManufacturer	Audi AG	dbo_cars_565041163_Audi_A2_)	HasProduct
HasName	Audi A2	dbo_prices_565041163_Audi_A2_France_)	OfProduct
HasPrice	10000	dbo_prices_565041163_Audi_A2_Germany_)	
	Car	dbo_prices_565041163_Audi_A2_Italy_)	
	Product	dbo_prices_565041163_Audi_A2_Portugal_)	
	TopSeller	dbo_prices_565041163_Audi_A2_Spain_)	
		dbo_sales_565041163_France_Audi_A2_)	
		dbo_sales_565041163_Germany_Audi_A2_)	
		dbo_sales_565041163_Italy_Audi_A2_)	
		dbo_sales_565041163_Portugal_Audi_A2_)	
		dbo_sales_565041163_Spain_Audi_A2_)	
		dbo_sales_565041163_Sweden_Audi_A2_)	
		dbo_sales_565041163_Switzerland_Audi_A2_)	



Extend the Ontology in the Wiki

- Create a new category

Press Ctrl+Alt+Space to use auto-completion. (Ctrl+Space in IE)

C Category Tree **P** Property Tree **R** Rules

[Add subcategory](#) | [Add cat. on same level](#) | [Rename](#)

GardeningLog (open)

Price (open)

[-] Product (open)

 Car (open)

[+] Region (open)

[+] Revenue (open)

 Sales (open)

 CarDealership (open)

I Instances

[Rename instance](#) | [Delete ins](#)

No instances available.

C Category Tree **P** Property Tree **R** Rules

[Add subcategory](#) | [Add cat. on same level](#) | [Rename](#)

GardeningLog (open)

Price (open)

[-] Product (open)

 Car (open)

[+] Region (open)

[+] Revenue (open)

 Sales (open)

 CarDealership (open)

 TopSeller (open)



Extend the Ontology in the Wiki

- Create a rule in the wiki with the editor

Derive Category **TopSeller** by complex rule

Head

All articles X_1 belonging to Category **TopSeller** are defined by

Body

All articles X_2 belong to category **RevenueByProduct**
AND
All articles X_1 belong to category **Product**
AND
All articles X_2 have the property **HasProduct** with value X_1
AND
All articles X_2 have the property **Value** with value a certain value > 100000
AND
Being member of a certain category or property

This rule implies the following:

Generate rule

R TopSellerRule

```
?X1:TopSeller :-  
  ?X2:RevenueByProduct AND  
  ?X1:Product AND  
  ?X2[HasProduct->?X1] AND  
  ?X2[Value->?__VALUE0] AND  
  ?__VALUE0 > 100000.
```

■ Property ■ Category ■ Instance



ObjectLogic Export

- To re-import the ontology in OntoStudio, export it via the OBL export bot.

This is the Gardening toolbox. It provides some tools which help to keep the wiki knowledgebase clean and consistent. To inspect the results of previous runs of the tools click on this link: [Special:GardeningLog](#).



Current / Recent bot activities:

User	Action	Start-Time	End-Time	Log	Progress	State		
WikiSysop	Export ObjectLogic	2011-03-21 14:25:22	2011-03-21 14:25:33	Log	100%	finished	Cancel Bot	Console log
WikiSysop	Export ObjectLogic	2011-03-21 14:13:04	2011-03-21 14:13:14	Log	100%	finished	Cancel Bot	Console log
WikiSysop	Export ObjectLogic	2011-03-21 14:09:51	2011-03-21 14:10:02	Log	100%	finished	Cancel Bot	Console log



Download Ontology from Wiki

- Exported ontologies are stored in the wiki as files.

[2011_03_21T15_48_51_ontology.obl](#) (file size: 108 KB, MIME type: unknown/unknown)

Warning: This file type may contain malicious code. By executing it, your system may be compromised.

noText

File history

Click on a date/time to view the file as it appeared at that time.

		Date/Time	Dimensions	User	Comment
delete all	current	14:48, 21 March 2011	(108 KB)	127.0.0.1 (Talk block)	(<i>auto-inserted file</i>)

- [Upload a new version of this file](#)
- [Edit this file using an external application](#) (See the [setup instructions](#) for more information)

File links

The following page links to this file:

- [Smw exportobjectlogicbot at 2011 3 21 15 48 58](#)

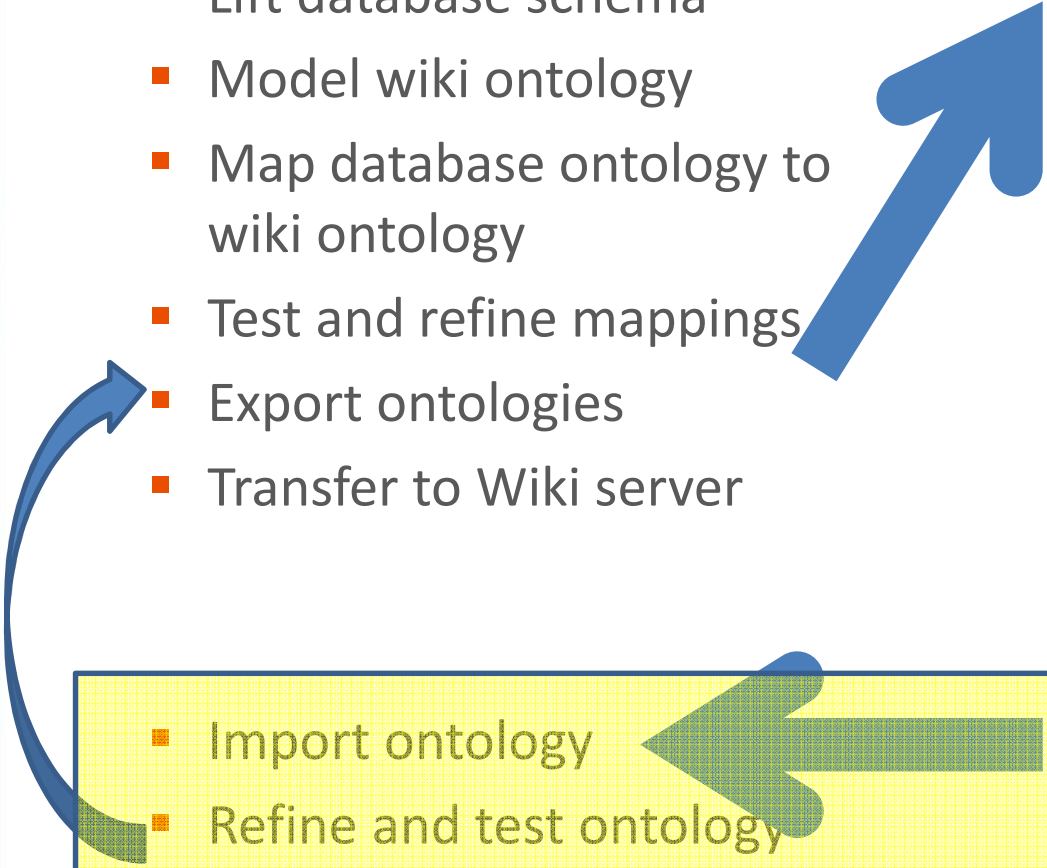
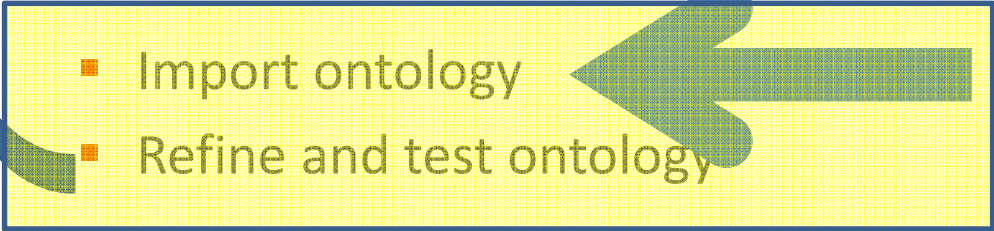


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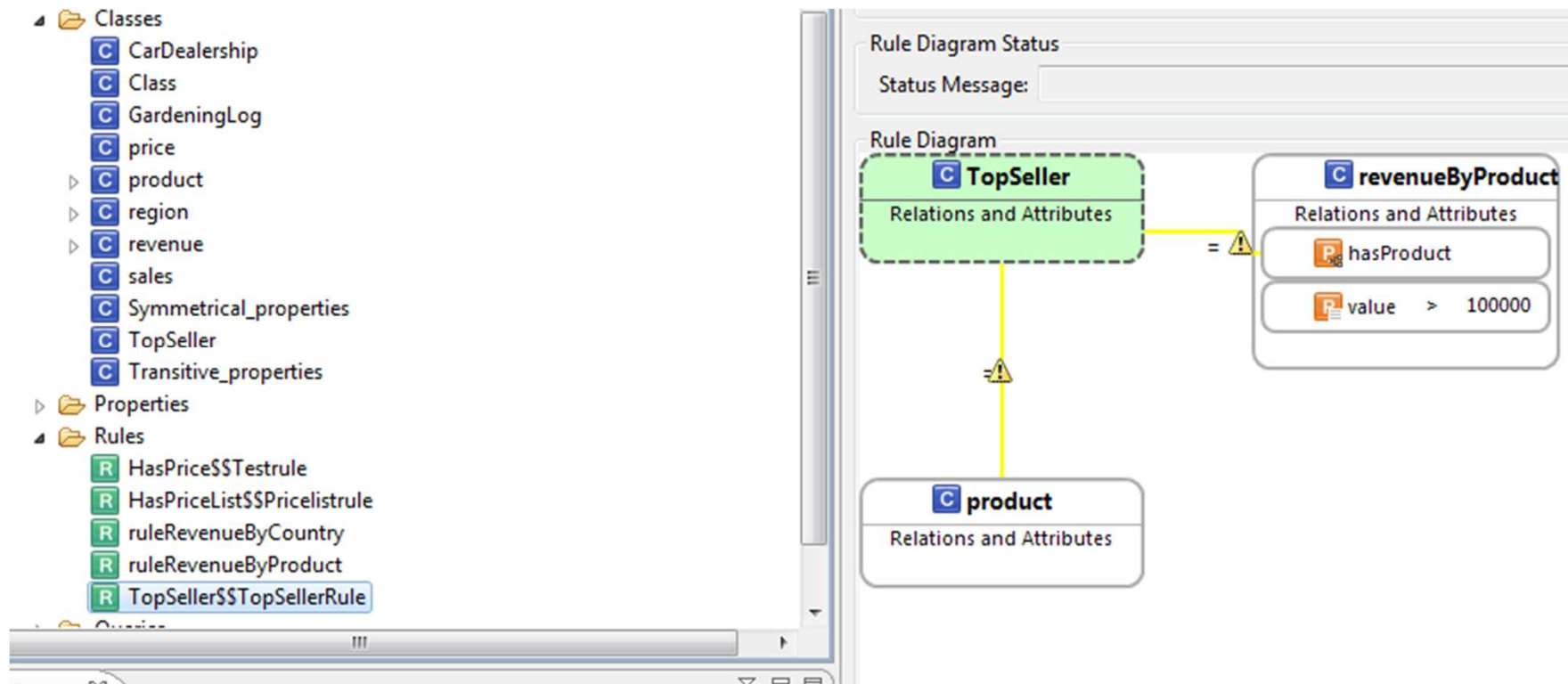
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- 
- 
- Import ontology
 - Refine and test ontology



Re-imported Ontology

- OS shows new wiki entities



Summary and Outlook

- SMW+ and TripleStoreConnector realize
 - Access to relational data from within SMW
 - Using the wiki vocabulary
 - Live queries
 - Enhance/Extend the data by wiki users
- Let's see how this combines with SPARQL endpoints
 - SMW's new SPARQL implementation
 - Federated queries
 - Against different sources
 - Different vocabularies (with and without mapping)



- Thank you!



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